Simulation of the Experiments with Ultracold Neutrons at the PIK Reactor

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Monte Carlo simulation of the complex of research with ultracold neutrons at the PIK reactor (Gatchina, Russia) is carried out. The complex is being built on the basis of a high-intensity source of ultracold neutrons at the GEK-4 channel. Superfluid helium is used as a converter of cold neutrons into ultracold ones. A Monte Carlo model has been developed, which includes a source, a neutron guide system and experimental installations, taking into account their real location in the main hall of the reactor [1,2]. Based on the simulation, it was found that, in a closed source chamber at a superfluid helium temperature of 1 K and a loss factor for the coating material of the inner walls of the chamber of $3 \cdot 10^{-4}$, a UCN density of $3.5 \cdot 10^{3}$ n/cm^3 can be obtained.

The sensitivities of measuring installations for the search for the electric dipole moment of the neutron and for the measurement of the neutron lifetime at the PIK reactor were obtained. For the experiment on the search for neutron electric dipole moment using a two-chamber magnetic-resonance spectrometer, it was found that the ultracold neutron density in the spectrometer chambers can be 200 n/cm^3, which is 50 times better than that in the ultracold neutron source at the Institute Laue-Langevin (Grenoble, France). At this density, a measurement sensitivity of $1 \cdot 10^{-27}$ e·cm/year is achievable, which will improve the existing neutron electric dipole moment measurement limit by more than an order of magnitude. For the experiment on measuring the neutron lifetime at the facility with a big gravitational trap, it was found that the counts of the neutron detector during emptyings are 50 times larger compared to that in the experiment at the Institute Laue-Langevin reactor, which is an indicator of the possibility of achieving a statistical accuracy of the measurement result of 0.1 s at equal duration of measurements.

1. A.K. Fomin, A.P. Serebrov, Technical Physics **67** (2022) 259.
2. A.K. Fomin, A.P. Serebrov, Journal of Surface Investigation **16** (2022) 1012.